

Design of Label Sorting Algorithm Program as Batik Pattern Drawer with Euclidean Distance Method

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Abstract: The development of technology pushes human to increase productivity by changing manual system to automatic system. Modernization affect almost all aspect especially in art. Batik is a ancestor legacy of indonesian people that recogized by UNESCO as culture legacy of Indonesia yet batik industries are not develop as much. Modernization in batik art is expected to optimize its productivity. This research design algorithm and the program in MATLAB that used for controlling movement prototype of batik maker 2 dof cartesian robot. The input data is a picture that will be processed to obtain the order of coordinate edge. Then it procesed and sent to plantby using MATLAB based on Graphical User Interface (GUI). The 2 dof Cartesian robot and a pen (end effector) is used to draw a pattern. A servo motor is installed to activate end effector and two stepper motor coupled with thread mechanic that used to move it towards the X and Y axis. Testing is done by sending coordinat orders to the plant or by observing drawing process order. Obtained error from program and algorithm testing is 2,32%.

Keyword: Batik, Matlab, GUI

1. INTRODUCTION

Indonesia is a country which has rich in art and culture. Indonesia has a lot of diversity in art especially painting and batik. Almost every region in Indonesia has a unique batik motifs according to the characteristics of their respective areas ranging from batik Cirebon, Pekalongan, Solo, Yogyakarta to batik Ubud in eastern Indonesia. Therefore, the world recognizes that batik is an original asset of Indonesian culture. Batik Indonesia is one of the world cultural heritage (World Heritage) which has been recognized and endorsed by United Nations Educational, Scientific, and Culture Organization (UNESCO) on October 2, 2009 [1].

The rapid technological developments in the world have an impact on advancements in various fields including development in robotics and industry. Technology advancement keeps pushing people forward to increase productivity especially on industry, we start to replace manual system to automation system [2]. Industrial world closely related to the world of robotics almost every industry uses robotic applications in running its production activities. Among the types of robots that are widely used in industrial productivity are the cartesian robots. The cartesian robot in its design has a structure consisting of three linear (prismatic) axes. Each axis can move into the X-Y-Z axis making it possible to get more accurate results in drawing batik patterns [3].

However the modernization of the art industry in Indonesia is not common. Modernization in the field of art, especially on fine art, closely related to the quality of image processing which enable wider application in various fields of high technology [4]. Graphical User Interface (GUI) in addition to being used as interaction between the user and the plant also allows it to be embedded with image processing program.

In previous research has been discussed about a robot designed to cut styrofoam automatically with two degrees of freedom. In this research the plant runs based on chain code algorithm program designed using Borland Delphi 7 software. By developing the concept of previous research, in this research will be discussed about design algorithms that build the program language with MATLAB Graphical User Interface (GUI) and generate coordinated sequential data output. The output will be processed in Arduino Uno microcontroller and it will move the plant in the form of prototype of cartesian robot in drawing batik pattern. It will be expected from this research to get program algorithm in MATLAB that allows plant to draw batik motif and pattern more accurate.

2. GUI

A GUI (Graphical User Interface) is a graphical display that contains a device or component that allows users to perform interactive tasks. Users do not need to create a script or write a command on the command line to perform a task [8]. GUI components can be menus, toolbars, push buttons, radio buttons, list boxes, sliders, and more. Matlab GUI can also display data in the form of tables or plots, and can be grouped with related components. A simple GUI example with Matlab can be seen in Figure:

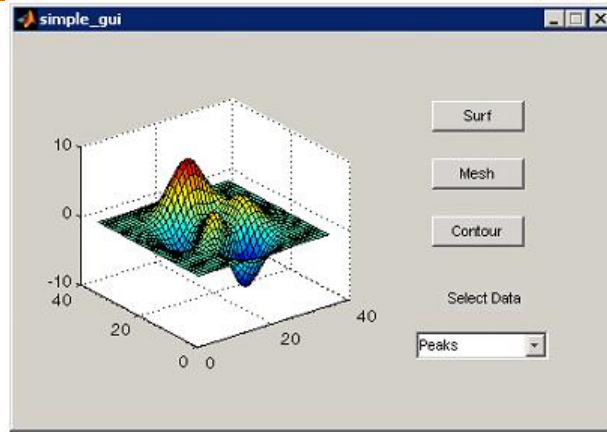


Fig. 1. A simple GUI example with Matlab.

2.1 Euclidean Distance

Euclidean distance is the most common type of cluster analysis distance measurement that used to measure the distance from a data object to the center of cluster. Euclidean distance is the geometric distance between the two data objects. The closer the distance, the more similar the data object.

In the general form of euclidean distance (d) can be obtained by:

$$x = (x_1, x_2, \dots, x_n) \quad (1)$$

$$y = (y_1, y_2, \dots, y_n) \quad (2)$$

In two dimensions, for example there are 2 coordinate points (x1, x2) and (y1, y2) as in the following figure :

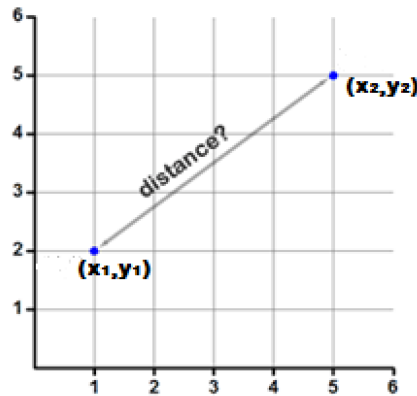


Fig. 2. Cartesian coordinates.

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (3)$$

Or it can also be established that [13]

$$d_e = \sum_{k=1}^m \sqrt{\sum_{k=1}^m (fd_{i,k} - k_j)^2} \quad (4)$$

d_e = euclidean distance
 fd_i = data training

k_j = test data
 m = amount of data training

2.2 Feature Extraction of Canny Edge Detection

Feature extraction is important in making of machine learning for classification or pattern recognition, which is information from the image can be obtained. One of them is edge detection. Edge detection is the first step to encompass the information within the image. The edges characterize the boundaries of the object and therefore the edge is useful for segmentation and identification processes within the image. The purpose of edge detection is to increase the appearance of the boundary line of an area or object in the image. The edge is a change of the intensity value of abrupt gray (large) in a short distance. The feature extraction of canny edge detection method is one of the modern edge detection algorithms invented by John F. Canny in 1986. In the following figure is the steps to perform canny edge detection [12]:

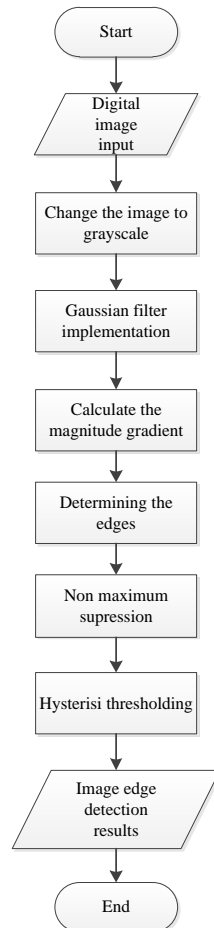


Fig. 3. Flowchart of canny edge detection process.

2.3 Software Design

GUI (Graphical Interface Unit) is created to facilitate the user in running the process. In the design, this GUI design will be built several panels that are tailored to the function of each panel.

The flowchart to build this GUI is:

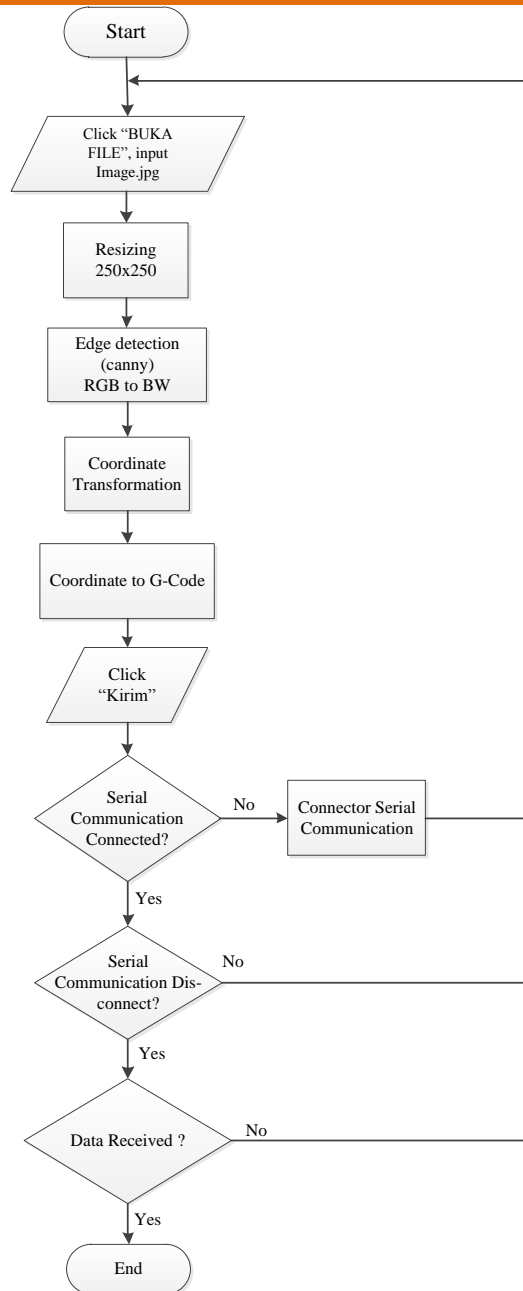


Fig. 4. Flowchart flow of GUI main program use.

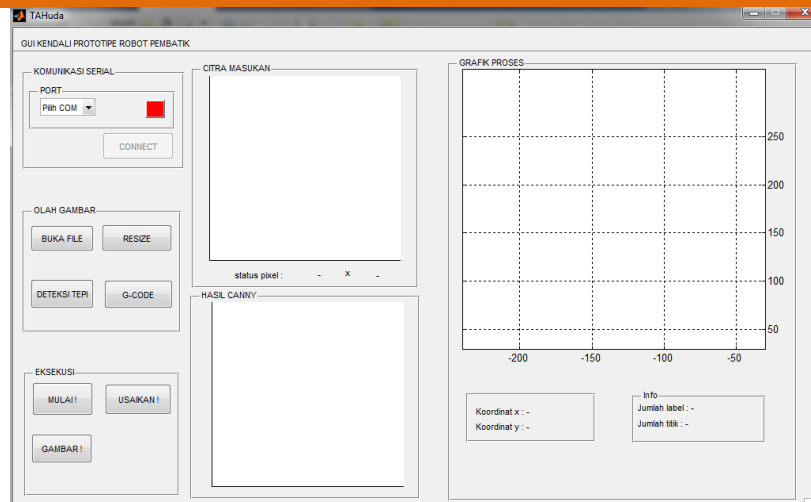


Fig. 5. Main program display.

Figure 5. shows the components that build the prototype of batik GUI, including serial communicating panels that work for serial connection, image processing panel to perform commands on image processing, the execution panel contains advanced commands after the completion of the process if the image, graphic input image, canny image graph, process graph to find out the order of depiction, then the info panel to find out the number of labels and dots detected by the program.

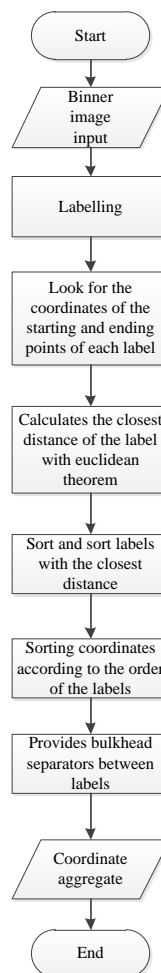


Fig. 6. Flowchart sorting coordinates.

The above flowchart can be spelled out into a few explanations below. Among others are:

1. Labeling Process

After the RGB image (red green and blue) is resized to 250x250 pixel size and determined by using edge detection of canny type, black and white image (BW) was created in the form of white contour edges that read as logic "1" while the black color will be detected as logic "0". The edge contours with their respective logic are present in the 250x250 pixel matrix, then the adjacent logic 1 form a plane or line will be classified into one label so as to obtain a number of labels in an image. The system assigns a label to a field or line on the pixel dimension of the matrix.

2. Search for starting point and end point of any number of labels

In this process the system will search the edge of a label located within any pixel coordinate. After obtaining the coordinates of the label edge, the next step is to take the coordinates of the starting point and the coordinates of the endpoints of one label until the end of label. So the data can be obtained from the starting point and end point sequence.

3. Calculate the distance of the nearest label

Since the coordinates of the starting and ending points on each label obtained, the system will calculate the distance between the starting point of one label and the endpoint of the other. The label sequence is determined by the distance that has the smallest value between the end of the initial label and the second label starting point. Then make a comparison between those points. Therefore once the sequence of labels along with their coordinate sequence obtained then the system will create a separator mark between labels. This is done with the purpose that the pen drawer (end effector) on the plant is able to distinguish when it will lower the drawing pen and when it will lift the drawing pen. The created coordinates indicate the lifting of the pen are (0,0), then it can be concluded that the coordinate between the labels is (0,0).

3. RESULT AND ANALYSIS

In this sub-section the testing is done by find out the correctness of the algorithm that has been made by sending Matlab output data to the plant so that it will produce the result image. Testing is done by interpreting the basic build pattern of batik motif that has been selected. Testing is done by following the steps according to the flowchart that has been discussed in the previous section.

3.1 Circle Shape

This test uses input data in the form of image files with the file type. JPG with the default pixel size. The pixel size is then resized to a random size of 250 x 250 pixels as shown in Figure 7.

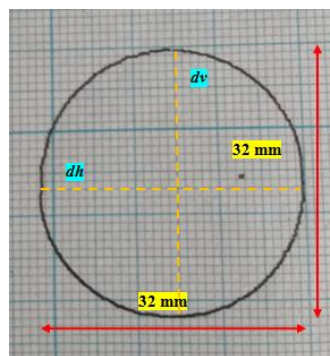


Fig. 7. of the circle image by the pen (end effector) plant.

Table 1. Boundary coordinate data on the circle

| Diameter | Start Coordinate | End Coordinate | Digital Picture Diameter (Length unit) | Plant Picture Diameter | Info |
|----------|---------------------|----------------|---|---------------------------|-------|
| dv | (2, 125) | (248,125) | 246 | 32 mm | Match |
| dh | (124,3) | (124, 249) | 246 | 32 mm | Match |

With regard to some things, if the dimensions of the image are not reduced will cause the plant to work is not maximal, then the dimension of the image is reduced from 37 mm x 37 mm to 33 mm x 33 mm by adding a big dividing factor in Matlab. From the data Table 1 it can be seen that the dimension of the maximum drawing range of the plant is 33 mm x 33 mm and the success condition can be known by paying attention to the magnitude comparison of symmetry. The diameter of the vertical and horizontal sides shows the same value in both the 246 Unit length and the 32 mm picture, the percentage of system success can be summarized 100%.

3.2 Square Shape

This test uses input data in the form of image files with the file type. JPG with the default pixel size. The pixel size is then resized to a random size of 250 x 250 pixels as shown in Figure 8.

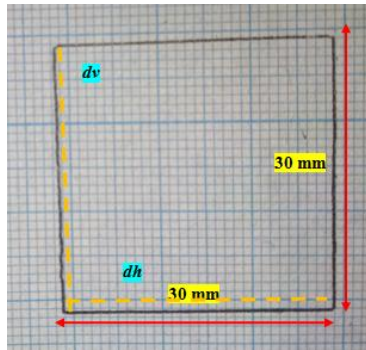


Fig. 8. square image results by pen (end effector) plant

Tabel 2. Boundary coordinate data on square

| Diameter | Start Coordinate | End Coordinate | Digital Picture Diameter (Length unit) | Plant Picture Diameter | Info |
|----------|------------------|----------------|---|---------------------------|-------|
| dv | (6, 243) | (6,6) | 237 | 30 mm | Match |
| dh | (6,243) | (243, 243) | 237 | 30 mm | Match |

With regard to some things, that if the dimensions of the image are not reduced will cause the plant to work is not maximal, then the dimension of the image is reduced from 37 mm x 37 mm to 33 mm x 33 mm by adding a big dividing factor in Matlab. From the data Table 2 it can be seen that the dimension of the maximum depiction range of the plant is 33 mm x 33 mm and the success condition can be known by paying attention to the magnitude comparison of symmetry. The diameter of the vertical and horizontal sides shows the same value of both the digital image of 237 Unit Length and the 30 mm plant image, the percentage of system success can be summarized 100%

3.3 Triangle Shape

This test uses input data in the form of image files with the file type. JPG with the default pixel size. The pixel size is then resized to a random size of 250 x 250 pixels as shown in Figure 9.

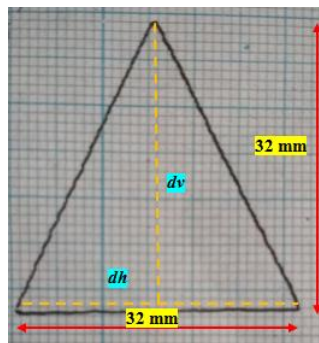


Fig. 9. triangular image by pen (end effector) plant

Tabel 3. Boundary coordinate data on triangles

| Diameter | Start Coordinate | End Coordinate | Digital Picture Diameter (Length unit) | Plant Picture Diameter | Info |
|----------|---------------------|----------------|---|------------------------|-------|
| dv | (126,248) | (126,2) | 246 | 32 mm | Match |
| dh | (3,248) | (249, 248) | 246 | 32 mm | Match |

With regard to some things, that if the dimensions of the image are not reduced will cause the plant to work is not maximal, then the dimension of the image is reduced from 37 mm x 37 mm to 33 mm x 33 mm by adding a big dividing factor in Matlab. From the data Table 3 it can be seen that the dimensions of the maximum depiction range of the plant is 33 mm x 33 mm and the success condition can be known by paying attention to the magnitude comparison of symmetry. The diameter of the vertical and horizontal sides shows the same value in both the 246 Unit Digital and the 32 mm picture, the percentage of system success can be summarized 100%.

3.4 Testing Batik Pattern Making

This test uses input data in the form of image files with the file type. JPG with the default pixel size. The pixel size is then resized to a random size of 250 x 250 pixels as shown in Figure 11.



Fig. 10. Original image that has been resized to 250 x 250 pixels.

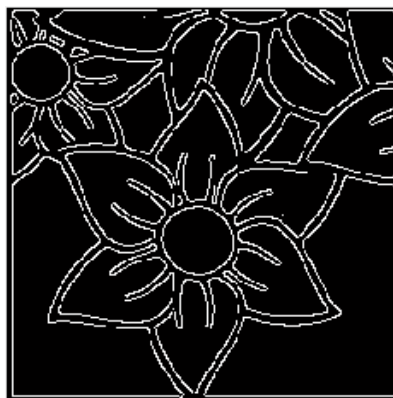


Fig. 11. Image edge detection results from the original image processing

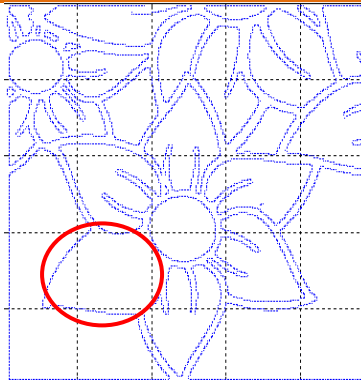


Fig. 12. Results of coordinate sequence processing algorithms with canny image input.

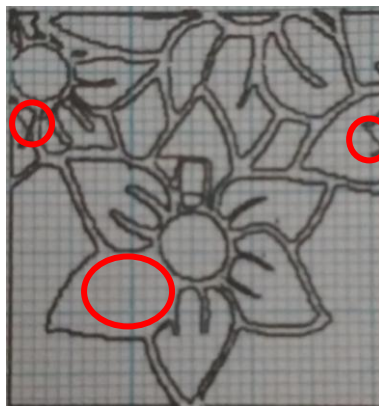


Fig. 13. The result of the depiction by the plant.

By analyzing Figure 10, Figure 11, Figure 12, Figure 13 it can be concluded that edge detection, which is the default Matlab algorithm capable of converting RGB image into edge image as shown in Figure 11 and the canny image is an input for the coordinate sequencing algorithm using the euclidean method. Under ideal conditions, Figure 12 will have the same result as Figure 13 but in Figure 13 there are several straight lines that are not identified as labels also drawn. This is because lack of program conditions on microcontroller and lack of stabilization on mechanical installation.

Therefore the error when drawing the label can be expressed as follows:

$$Error \ (%) = \left| \frac{nilai_aktual - nilai_ideal}{nilai_ideal} \right| \times 100 \%$$

$$Error \ (%) = \left| \frac{42 - 43}{43} \right| \times 100 \%$$

$$Error \ (%) = 2,32 \%$$

Maka dapat disimpulkan *error* program adalah 2,32%

4. CONCLUSION

Based on testing and analysis that has been done, it can be concluded several things as follows:

Designed algorithms have been successfully simulated on both the GUI chart and on the Cartesian robot plant. The prototype of cartesian robot maker of batik pattern based on Graphical User Interface has been successfully designed by generating program error of 2.32%. Graphical User Interface as a cartesian robot interface has been successfully designed and all functions work properly. The interface is designed with data transfer rates of 9600 bits per second. The prototype of the cartesian robot succeeds in making archetypal patterns of square, circle, and triangle and pattern of flower batik motifs.

REFERENCES

- [1] UNESCO, “Evaluation of the nominations for inscription on the Representative List of the Intangible Cultural Heritage of Humanity,” 2009.
- [2] D. Z. Aridanana, E. Sunarno, dan M. Saifudin, “Rancang Bangun Konveyor Untuk Sistem Sortir Berdasarkan Berat Barang,” Laporan Tugas Akhir, Politeknik Elektronika Negeri Surabaya, Surabaya, 2010.
- [3] Pitowarno, Endra, (2006). Robotika: Desain, Kontrol, Dan Kecerdasan Buatan. Buku Teks. Yogyakarta: ANDI. 1-3
- [4] V. Kale dan V. Kulkarni, “Object Sorting System Using Robotic Arm,” *Int. J. Adv. Res. Electr. Instrum. Eng.*, vol. 2, no. 7, pp. 3400–3407, 2013.
- [5] __, Matlab 7 - Creating Graphical User Interfaces. MathWorks, Inc., 2007.
- [6] Dr. Raden Supriyanto, dkk, Buku Ajar Robotika Kata Pengantar, 2010, Gunadarma University
- [7] Johnson, A. R dan Dean W. Wichem. 2002. Applied Multivariate Statistical Analysis. Edisi ke-5. New York: Prentice-Hall, Inc.

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